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ABSTRACT

Net-a-Morphosis in Teacher Education is a component of the ThinkQuest for Tomorrow's Teachers grant designed to prepare teachers who are proficient in technology use in the classroom and able to effectively infuse it across subject areas and grade levels to enhance learning. This study examined the results of teacher education faculty and preservice teachers being engaged in the integration of technology applications into teacher education coursework over a 2-year period. The instructional model for infusion of technology was guided by participants' varying developmental levels, collaborative strategies, constructivist pedagogy, and reflective practice. The study used a mixed method research design. Data were collected from all participants through survey instruments and reflective narratives. The themes that emerged add to the understanding of the processes essential to the construction of new levels of meaning when teacher educators and preservice teachers concurrently engage in the incorporation of a technology innovation to enhance the delivery of content. Five appendixes present data on: Net-a-Morphosis in teacher education courses; the ThinkQuest T3 catalyst grant exiting preservice teacher questionnaire; the final project reflection activity; the project faculty annual survey; participating preservice teachers' reflective themes; and Net-a-Morphosis in Teacher Education faculty reflection themes. (Contains 26 references.) (Author/SM)

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Abstract

This study examined the results of teacher education faculty and preservice teachers engaged in the integration of technology applications into teacher education coursework over a two year period. The instructional model for infusion of technology was guided by participants' varying developmental levels, collaborative strategies, constructivist pedagogy, and reflective practice. The study used a mixed method research design; data were collected from all participants through survey instruments and reflective narratives. The themes that emerged add to our understanding of the processes essential to the construction of new levels of meaning when teacher educators and preservice teachers concurrently engage in the incorporation of a technology innovation to enhance the delivery of content.

Net-a-Morphosis in Teacher Education

Introduction

Net-a-Morphosis in Teacher Education is a component of the ThinkQuest for Tomorrow's Teachers (T3) grant which is funded in part by the US Department of Education through a Preparing Tomorrow's Teachers to Use Technology (PT3) catalyst grant. T3 is an effort undertaken by a consortium of colleges, universities, school districts, and non-profit organizations and businesses led by ThinkQuest, to prepare teachers who are not only proficient in using technology in the classroom, but are able to effectively infuse it across subject areas and grade levels to enhance the learning of P-12 students.

One School of Education's T3 project, *Net-a-Morphosis in Teacher Education*, engaged six faculty members in the implementation of the grant during Year One. In the second year, four of the original faculty returned and three new faculty were involved. During the two years over 300 preservice teachers at various stages in their programs of study participated in a model that incorporated the general goals of the T3 catalyst grant with specific ones for the School of Education. *Net-a-Morphosis in Teacher Education* was designed to infuse technology into teaching strategies and resources through collaborative and cooperative processes and a constructivist pedagogy; engage preservice teachers in peer review and reflective practice; and enhance the professional development of teacher education faculty. Traditional and non-traditional preservice teachers from several different education programs offered through the college and from a range of geographical campus locations participated in the *Net-a-Morphosis in Teacher Education* project. Faculty applied the model to a variety of different of courses including those

with an emphasis on methods, foundations, exceptional student education, and Teaching English for Speakers of Other Languages (TESOL). Participating faculty and students brought vastly diverse perspectives, degrees of technology knowledge and expertise, and enthusiasm to the project.

This paper, in examining the results of two years of participation in the project, seeks to add to our understanding of the processes that occur when teacher educators and preservice teachers concurrently engage in developing new knowledge, skills, experiences, and values that are specifically related to the incorporation of technology in teaching and learning processes. Through examination of the impact of this project on participating faculty and preservice teachers, the paper also addresses the developmental changes that occur as preservice teachers and teacher education faculty engage in collaborative efforts and reflection.

Theoretical Framework

The rationale for such a project is well-documented. Although access to educational technologies in K-12 schools and classrooms is evident (Becker, 1999; Skinner, 2002), classroom practitioners have not embraced the technologies to the extent that they integrate their uses seamlessly into the K-12 curriculum (NCES, 2000). Research indicates that most computer use is for drill and practice activities, basic word processing applications, and research or information gathering in the elementary through high school classrooms (Becker, 1999; NCES, 2000). Despite an average ratio of one instructional computer with Internet access for every 5.4 students (NCES, 2002), a substantial number of teachers report that they do not use computers and other technologies regularly for instruction (Becker 1999; NCES, 2000). Though there are

numerous barriers to the effective use of computer technologies in classrooms, a primary concern expressed through much of the literature is the need for teacher education in the use and integration of these technologies for critical and higher order thinking, collaboration and audience presentation (Becker, 1999).

Through the *Net-a-Morphosis in Teacher Education* project, preservice teachers and teacher education faculty were immersed in the use of technology both as content and as a medium of instruction. The *Net-a-Morphosis* model provided an opportunity for preservice teachers and teacher education faculty to reflect on their own existing levels of technological expertise and dispositions towards technology as an instructional medium and to develop their technical expertise based on their existing knowledge and dispositions. Faculty were provided the opportunity to explore the infusion of Internet technologies into their content and methods courses, incorporating higher order thinking experiences for their preservice teachers and modeling how these developing professionals could use technology to promote higher level thinking with their P-12 students.

Developmental stages

Based on the literature on teacher competence and experienced and expert teachers (Berliner, 1988; Sternberg & Horvath, 1995), diffusion of innovations models (Rogers, 1995), and the Apple Classroom of Tomorrow (ACOT) studies of adoption of technology (Fisher, Dwyer, & Yocam, 1996), the *Net-a-Morphosis* model considers the stages of development of beginning and experienced teachers adopting a new approach to teaching. Sternberg and Horvath (1995) suggest an Expert Teaching Prototype with three primary features distinguishing the expert from the novice: knowledge, efficiency, and

insight. Briefly, the Expert Teaching prototype suggests that experts bring more knowledge to bear in solving problems and do so more effectively and efficiently than do novices. Further, experts are more likely to arrive at creative solutions to problems than their novice counterparts. Sternberg and Horvath are quick to clarify that not every experienced teacher is an expert teacher. The expert teacher, then, is knowledgeable and can access and organize this extensive knowledge for use in teaching.

Berliner (1988) presents his Pedagogical Developmental Stages, focusing on describing teachers' behaviors within each of the five proposed stages. The stages characterize teachers in terms of their classroom processes, interpretation of classroom events, attention to feedback from classroom activities that affect immediate decision-making, and schema development. The five pedagogical developmental stages are: novice, advanced beginner, competent, proficient, and expert.

In general, novice teachers, when confronted with new curricula or pedagogical approaches, begin with the literal, obvious aspects of the lesson or content. Teachers must first comprehend the content and develop a skill base with it before they can begin to apply the material to a learning situation. As teachers gain expertise, they begin to strategize how to teach with the new material and discover and create applications in the classroom with the new material. Later, teachers begin to focus on the interactions of the students with the content and teaching experiences and focus less on the "prescriptive" aspects of the curriculum. As teachers become accomplished with the given content, they re-work it into their personal instructional repertoire, building on it and reshaping it to accommodate their teaching philosophies, beliefs about learning, and student needs and interests.

As applied to the infusion of technology into their repertoire of teaching practices, the preservice teachers and university teacher education faculty would first learn how to use the technology for personal productivity and practice with it. Later, they would determine how it may be used with students and then incorporate it into their teaching practices. At the beginning stages, preservice teachers and teacher education faculty may be observed applying technology as an adjunct to other content and teaching practices. Later, one would expect to observe less focus on how to use the technology and more on using the technology to expand and enhance the learners' understanding of the content.

This stage-oriented continuum loosely parallels models for diffusion of innovation. Rogers (1995), for example, suggests five stages in the "innovation-decision process through which an individual passes from first knowledge of an innovation, to forming an attitude toward the innovation, to a decision to adopt or reject, to implementation of the new idea, and to confirmation of this decision" (p. 163). The ACOT research proposes stages of development for teachers to embrace technology for use as a routinized part of the curriculum (Dwyer, Ringstaff, & Sandholtz, 1990). The stages begin with acknowledgement of the technology's presence; using it for traditional teaching tasks; adapting it to specific elements of the teaching and learning process and enhancing productivity; using it effortlessly and with minimal cognitive expenditures; and creating new knowledge and learning experiences with the innovation. As teachers consider adoption of a new curriculum or content, they may be observed, over a period of time, moving through the stages of adoption as described by Rogers or the ACOT studies. Critical to the success of the acceptance and adoption of technology use as pedagogical practice is the recognition of these varying stages of development.

Constructivist pedagogy

Constructivism is a theory of learning that is based on two premises: 1) learning begins with "the knowledge, attitudes, and interests that students bring to the learning situation, and 2) learning results from the interaction between these characteristics and experience in such a way that learners construct their own understanding" (Howe & Berv, 1999, p. 19). For understanding to occur, content needs to be offered in multiple contexts so that learners can construct personal meanings of the content (O'Donnell, 1997). This understanding requires that learning tasks be authentic, interesting, and meaningful. The *Net-a-Morphosis in Teacher Education* model provided for content related to the infusion of technology to be presented in various contexts such as classroom lectures, discussions, and assignments, in online and offline sources, and in clinical experiences. Since preservice teachers chose topics and content for their projects and the projects were implemented in P-12 classrooms, the tasks were authentic, interesting, and meaningful.

Collaboration and the Guiding Partner Approach

Learners in the *Net-a-Morphosis in Teacher Education* project worked cooperatively to complete web-based projects that integrate technology involving interdisciplinary content. An integral component of instructional applications of constructivism is collaboration wherein learners construct personal meanings of knowledge both individually and collectively. The teacher and peers facilitate each learner's cognitive construction by providing the setting, posing challenges, and offering support (Lunenberg, 1998) and offering each learner opportunities "to reflect on and elaborate not only their own ideas but also those of their peers as well" (p. 77).

Joyce and Showers (1988) incorporate peer coaching in their teacher staff development model. This approach takes advantage of the knowledge and experience of the participants, while considering the self-concept, motivations, and learning propensities of the student. In the peer coaching model teachers learn from one another as they plan for instruction and develop support materials, watch one another work with students, and think together about the impact of their behavior on their students' learning (Showers & Joyce, 1996). They point out that coaching is not observing and then giving feedback, but rather working side by side.

The Guiding Partner Approach (GPA), which is an integral element of the *Net-a-Morphosis* model, is built on the constructs of collaboration and constructivism. It "is comprised primarily of two intertwined notions: *students and teachers as junior/senior colleagues in the learning process* and *the use of flexible frameworks for instructional design*" (Harris, Eskridge, & Sibley, 1999, p. 1). In the GPA, university faculty collaborate with preservice teachers to design and implement learning activities that use Internet-based technologies for higher order thinking and learning experiences for P-12 classroom use. The *Net-a-Morphosis* model provides opportunities for preservice teachers to work in teams to design and develop technology-infused P-12 content and learning experiences; faculty to work collaboratively with their preservice teachers to coach and mentor each other with content and technology use; and faculty to work collaboratively among themselves to dialogue, share, reflect, and learn from one another. Often teachers and university faculty work in isolation. The *Net-a-Morphosis* project provides the structure for teacher education faculty to team-teach, share expertise, and support one another while offering experiences for preservice teachers to work

collaboratively in designing instructional materials and establishing patterns of teaching behaviors that eventually will come to fruition in P-12 classrooms.

Grossman, Wineburg, and Woolworth (2000) provide information about components of a community of learners. These include common language; common purpose and vision; willingness to listen to different perspectives and try to understand them; and development of new ideas among community members. The participants in *Net-a-Morphosis* listened to each others' ideas and opinions, leading to the development of new ideas among the members of the community of learners. Oja et al. (1995) state when a community of learners has developed, "All members of the collaborative are learning from each other. No one person is considered an expert in everything. Each person has valuable contributions to make to the education of the community" (p. 11).

Building on the theory of developmental stages and coupling that with constructivist principles and collaborative strategies, the *Net-a-Morphosis* model provides an atmosphere and framework wherein preservice teachers and teacher education faculty can feel safe, supported, and stimulated. Such an infrastructure serves as fertile ground for the refining and advancement of skills and practices, the development of new ideas, and the nurturing of values and dispositions. Collaborative engagement provides the scaffold for individuals as they consider the adoption of a new curricular approach or an innovative strategy. When such practice is based on the individual's current knowledge, skills and dispositions--in essence, considering the individual's developmental stage as related to the novel approach--the stage is set for authentic and meaningful learning.

Reflective Practice

Reflective thinking is another integral component of the *Net-a-Morphosis in Teacher Education* model. Dewey (1933) reminds us that learning improves to the degree that it arises out of reflection, thus limiting impulsive teaching and helping the educator to act deliberately and intentionally. Reflection involves hindsight, looking inside oneself, looking at situations, taking time for re-education, awareness, observation, practice in teaching, questioning, and mindfulness of consequences. Throughout the course of involvement in the project, preservice teachers and university faculty were involved in varying levels of reflection and reflective practice as they negotiated their way through the stages of technology infusion required. As educators think deeply about what they are doing, when they "reflect" on their words and actions, they are led to ask better questions, to break out of useless routines, to make unexpected connections, and to experiment with new ideas. "Reflective practice celebrates the organic above the artificial. It emphasizes the primacy of experience above linguistic representation" (Wellington, 1991, p. 4). University faculty in the *Net-a-Morphosis* project embraced a model of narrative inquiry, modeling reflective practice through their engagement in inquiry oriented teaching, and using a cycle of thought and action based on professional experience and the integration of new knowledge, skills, and dispositions.

In *Coaching Reflective Teaching*, Schön (1988) focuses specifically on how teachers as professionals can be educated to become reflective practitioners. The appropriate instructional supervision needed for this is "coaching." Through advice, criticism, description, and demonstration of questioning, one person helps another learn to practice reflective teaching. Reflective teaching and supervision are kinds of research

in practice. Teaching is a form of "reflection-in-action;" it is a reflection of phenomenon. In reflective supervision, the coach helps, probes, and encourages the teachers to reflect on their own practice. It is through the demonstration of reflective teaching that the novice can begin to focus on the complexities of instructional decision making. While it is apparent that some teaching decisions are made after careful deliberation prior to or after instruction, others are made spontaneously during instruction. In many cases, these spontaneous decisions are based on previous dilemmas.

In *Net-a-Morphosis*, preservice teachers and faculty posed and solved problems related to technology infusion while engaged in various stages of reflective practice. This oftentimes involved the examination of values and assumptions, and the purposes of what they were creating which is critical if teachers are to be involved as creators of curriculum knowledge, not just consumers (Zeichner & Liston, 1996). This reflective component served to help preservice teachers and faculty internalize the learning experience of technology integration.

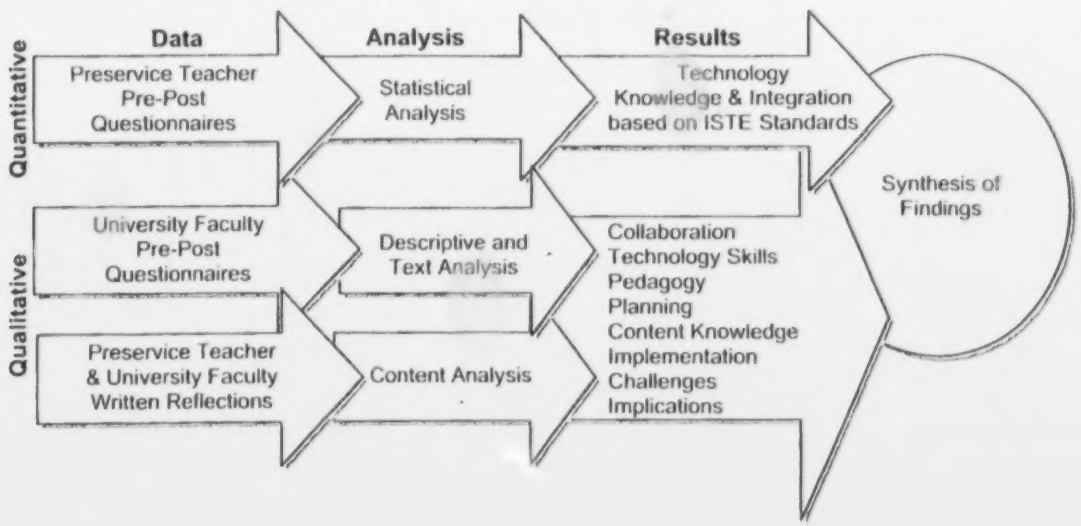
Teaching individuals to be reflective practitioners is only one dimension of the notion of creating and nurturing reflectivity. This dimension encompasses nurturing of the individual--building self confidence and self esteem, allowing experimentation, teaching them to be thoughtful and analytical about what they do. The other aspect of nurturing reflectivity is in building "a community of discourse." It is very important for novices, as well as experienced educators, to be able to function and reflect on many levels, with colleagues, peers, parents, administrators, and P-12 students. Consistent dialogue is essential between the sub-cultures within the school culture, and this was exemplified as all participants utilized the GPA throughout the project.

Method

Research Design

A mixed method research design was selected for this study in order to confirm and converge findings from a variety of data sources. This study used self-reporting pre- and post- preservice teacher and teacher education faculty questionnaires as well as reflective narratives recorded throughout the study. Data were collected concurrently and a parallel mixed model for data analysis was utilized to offset the limitations of the self-reported questionnaire data with the strengths of the rich narratives of the reflective reports. The triangulated data were analyzed using both statistical analysis and coding procedures. A visual model of the research design can be found in Figure 1.

Figure 1. Research design model for the study of technology infusion by preservice teachers and teacher education faculty.



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The researchers posed the following question:

> To what extent does the infusion of technology into pre-service teacher education courses through collaborative and cooperative processes using a constructivist pedagogy increase student and faculty knowledge, skills, and dispositions toward the use of technology in P-12 classrooms?

Setting and Participants

Nine teacher education faculty from a mid-sized, independent, urban university participated in the project over a two year period. Six faculty participated in the first year. In the second year, four of the six returned and three new faculty were added. All were full-time education faculty teaching courses in a variety of teacher education programs and at several campus locations. Faculty selected one or two courses that they taught in which to implement their plans for the *Net-a-Morphosis in Teacher Education* project. Students enrolled in these particular sections of courses then became the preservice teacher participants for the study. Appendix A summarizes the courses in which the project was implemented and the number of participating preservice teachers registered in each course.

Preservice teachers from different programs and from various sites participated in the project. Preservice teachers included those taking their first education course to those completing their last course before beginning their student teaching. These preservice teacher participants included individuals from traditional undergraduate and graduate teacher preparation programs, second career preservice teachers who had already earned a bachelor's degree, and non-traditional students who worked full time, supported a

family, and were enrolled in evening classes. During the two years of the project, 141 preservice teachers participated in Year One and 153 in Year Two.

Implementation

At the beginning of the Spring and Fall semesters 2002, participating faculty members attended T3 grant-sponsored consortium workshops designed to offer professional development opportunities addressing the goals and objectives of T3, the GPA, exploration of effective models of technology integration, reflective writing practices, and presentations by consortium partners. An additional benefit of the workshops was the opportunity for participating faculty members to travel together and engage in reflective dialogue, planning activities and sharing of ideas concerning teacher preparation programs.

Communication and feedback related to project pre-planning and implementation for all participating faculty was continuous. Throughout the duration of the project, both formal and informal meetings were scheduled to provide support, explore institutional resources, and schedule project activities. Faculty collaborated with one another as they planned, prepared, and implemented the individual projects in their courses. To support the unique designs of each project, individualized technology training was made available to participating faculty members intended to enhance faculty technology literacy needs based on course content. Additionally, the project director worked with participating faculty to develop project activities and to team-teach in various courses throughout the semester.

A wide range of activities to support preservice teachers' integration of technology into their teaching practices was developed and implemented throughout the

study. These included the design, development, and implementation of WebQuests and web-based interactive PowerPoint presentations; video recording, editing, and streaming of instructional material for elementary-aged students; the integration of interactive activities into implemented P-12 curriculum unit plans; educational software reviews; Internet-based research; and the creation of web pages. Specialized technology mini-sessions were conducted in the content courses to provide instruction for the preservice teachers on the use and integration of specific technologies. Course specific handouts and support resources were available to preservice teachers to support the integration of technology. Furthermore, preservice teachers received preparatory training and support in posting their team projects to the T3 website (http://t3.preservice.org). Preservice teachers worked collaboratively in teams to design, develop, and in many cases implement their *Net-a-Morphosis* projects. Participating preservice teachers shared their team projects with the university community at an end-of-semester celebration/poster session conference. Additionally, several preservice teams shared their projects at a local professional conference.

Data Collection Strategies

In this mixed method study, data were collected using survey instruments administered to participating and non-participating faculty and preservice teachers. Reflective narratives written by participants were also analyzed.

Preservice teacher data. Reflective narrative data were collected from participating preservice teachers in both years; survey data were collected only for participants in Year Two. Eighty–eight complete survey data sets were analyzed from the Year Two participants and approximately 200 written narratives from both Year One and

Year Two participants were collected. The ThinkQuest PT3 Catalyst Grant Exiting Preservice Teacher Questionnaire (see Appendix B) is the evaluation instrument that was used in the Spring of 2002 with a comparison group of non- project preservice teachers and again in the Fall of 2002 as a pre- and post-survey with project participants. The close-ended question survey instrument was developed in 1999 by the Center for Evaluation and Research, LLC and is based on the International Society for Technology in Education (ISTE) teacher standards. The 22-item survey addresses a) technology operations and concepts; b) planning and designing learning environments; c) teaching, learning and the curriculum; d) assessment and evaluation; and e) productivity and professional practice. Preservice teachers are asked to respond to each survey item by selecting among four Likert format responses: 1 = not prepared; 2 = somewhat prepared; 3 = prepared; and 4 = well prepared.

In addition to collecting the questionnaire data, preservice teachers submitted written reflections to their course instructor in a variety of formats. Decisions on formats were determined based on course content, required assignments, and levels of technology literacy. Among the formats chosen were e-reflections, interactive journals, and a final reflective narrative guided by probing questions. In this final reflective narrative preservice teachers were asked to address the following topics based on *Net-a-Morphosis* activities and defined as: a) experiences, engagement activities; b) sensory input, sensory-based observations; c) processing, interpretational observations; d) generalizing, understanding and making connections; and e) practical application, active experimentation. The final reflective activity was distributed and completed the last week of the Spring and Fall semesters 2002 (see Appendix C).

Teacher education faculty data. Two faculty surveys were utilized. Participating faculty completed the ThinkQuest PT3 Catalyst Project University Participating Faculty Annual Survey (see Appendix D) and non-participating faculty were given a modified version of this instrument. The Faculty Annual Survey is a six-item questionnaire containing three open-ended and three multi-part close-ended questions. This survey instrument also was developed in 1999 by the Center for Evaluation and Research, LLC specifically for use with the ThinkQuest for Tomorrow's Teachers PT3 catalyst grant. The modified questionnaire containing four items, given to non-participating faculty in the Spring of 2003, asked faculty to respond to items concerning their understanding and use of constructivist pedagogy, computer and Internet technologies, and web-based learning activities; their frequency of use of and applications for a variety of computer technologies; and their self-evaluation of their stage of development, based on Rogers' (1995) stages of adoption of an innovation. The original questionnaire completed by participating faculty in the Spring of 2002 and the Fall and Spring of 2003 had two additional questions specific to the faculty involvement in the T3 project. In addition to completing the pre- and post-questionnaires in Fall 2002 and Spring 2003, faculty engaged in writing reflective narratives throughout their involvement in the project. In most cases these were e-reflections and journals.

Data Analysis Procedures

Data analysis consisted of both quantitative and qualitative techniques. Univariate analyses were conducted on the preservice teacher survey data. Text analysis was performed on the open-ended responses of the surveys and the written reflections. As part of these analyses, some of the qualitative data were quantitized by counting the

frequency of occurrences of responses. Results are presented both in terms of quantitative results and qualitative inferences.

Preservice teacher data analyses. Data from the Exiting Preservice Teacher Surveys administered to non-participants as a comparison group and to participants as a treatment group (those who participated in the project) were examined. First, data from the comparison group were compared to post-survey data from the treatment group. A Mann-Whitney U Significance Test for interval data rankings as well as an independent samples *t*-test were used to compare the two groups.

Next, pre- and post-survey data from the treatment group were analyzed to determine if a difference existed between the pre- and post-survey results. Treating the data as ordinal, the Wilcoxon signed rank test was used. The data were also treated as interval and pre- and post-analyses for the scale as a whole (22 items) were computed, as well as for each of the subsections.

The preservice teacher narrative data were examined using a constant comparative analytical scheme. First, the text was broken into units of information to serve as a basis for defining themes. This was facilitated by the probing questions (see Appendix C) to which the preservice teachers were asked to respond in their final reflective narratives. Next, the data were chunked, initially into ten, then ultimately into seven categories. These seven categories emerged as the dominant themes in the preservice teachers' written reflections (see Appendix E).

Teacher education faculty data analyses. The participating faculty reflective narratives were analyzed using the same approach of unitizing and then categorizing. The responses to the open-ended questions on the faculty survey were first quantitized,

noting frequencies of similar responses, and then analyzed for content. Three dominant themes emerged (see Appendix F).

Findings

After Year One of the project, it was apparent that students' technology knowledge, skills, and dispositions as related to the use of technology as an instructional resource were positively enhanced as evidenced through discussions, written reflections, and student products. The results observed in Year Two added new insights and were richer in complexity due to increased data sources. In Year Two there was a greater emphasis on the impact of the project on participating faculty.

Preservice teachers

The results of the Mann-Whitney U Significance Test yielded statistically significant higher levels of preparation for two of the twenty-two competencies for the comparison group: a) Design developmentally appropriate learning opportunities that apply technology-enhanced instructional strategies to support the diverse needs of learners ($p<.01$), and b) Apply current research on teaching and learning technology when planning learning environments ($p<.01$)). The statistically significant differences disappeared when an independent sample *t*-test was run. The average rating across all 22 items by the comparison group ($M=3.36$, $SD=.56$) does not differ to a statistically significant degree (using alpha=.05) from that of the treatment group ($M=3.23$, $SD=.52$), $t(242)=1.757$, $p=.08$. In fact, even when means are computed for each subscale of the questionnaire (item 1 alone; items 2-6; items 7-10; items 11-13; items 14 – 17; and items18-22) and compared between the comparison and experimental groups, no statistically significant differences emerge. No statistical difference was found between

the results of the survey distributed to the comparison group of preservice teachers in the Spring 2002 and the post-survey results from the administration of the of survey to the participating preservice teacher in Fall 2002.

The results of the Wilcoxon signed test indicated that the experimental group showed change in the positive direction for all 22 survey items. Again, for the scale as a whole and for each subscale, statistically significant improvement is perceived by those in the treatment group following the intervention. When comparing the results of the pre-survey to those of the post-survey administered to participating preservice teachers in the Fall of 2002, the data show that a change occurred in a positive direction for all 22 survey items.

Through reflective practices, preservice teachers gained insight into who they are both as learners and as teachers. By engaging in reflective practices and reflective writing activities, preservice teachers expressed the importance of learning from the process as well as the importance of the final product. Various themes emerged from the participating preservice teachers' reflections (see Appendix E). The most salient themes were: technology knowledge; content area knowledge; collaborative process; constructivist pedagogy; planning and implementing curriculum; challenges; and implications. Preservice teacher reflections demonstrated growth over time throughout the implementation of the *Net-a-Morphosis* project. These reflections, collected through journal writing or specific reflective writing assignments, provided significant opportunities to support preservice teachers' development of complex understandings in the areas of technology and the content areas.

The knowledge and skills that preservice teachers gained in the area of technology were evident. Preservice teacher reflections indicated that class assignments required them to develop a variety of technology skills. Acquired skills included creating PowerPoint presentations; importing sounds and images into PowerPoint as well as integrating videotaping; hyperlinking websites and PDF files; posting work to the T3 website; designing WebQuests; selecting, evaluating, and teaching with instructional web-based materials; designing web pages; and conducting Internet searches.

Subject area content knowledge and understandings were being co-constructed by participants throughout the project. By faculty modeling constructivist pedagogy, preservice teachers discovered new approaches for teaching students. Through the collaborative planning, preservice teachers reported feeling they had achieved a higher level of understanding of the subject matter. By evaluating websites that provided content information and instructional activities, preservice teachers were able to obtain greater understanding beyond the traditional means such as course textbooks. Content understanding was further enhanced as preservice teachers worked together and shared their newly found knowledge. Preservice teachers' reflections indicated that they will continue to utilize knowledge and skills gained through their participation in the project.

Another theme that emerged in the preservice teacher reflections related to the collaborative process and the GPA. Preservice teachers were anxious and nervous about using technology, especially those with limited skills. However, these feelings of anxiety dissipated as they started to work in collaborative groups and received support from one another as well as from the faculty. Reflections indicated that by working collaboratively

they were able to share thoughts and learn from each other; learn to work out differences; be more patient; and to listen to everyone's opinions. One preservice teacher stated:

> "Through doing a WebQuest I have learned many new things about myself as a teacher. I have learned that working with other people is not always easy, but it must be done to achieve a goal. Throughout this project I did not know how to communicate with my group members effectively. However, I now understand that working with others cooperatively is very important in the overall success of a project, and I understand now how to communicate that to others. I believe this will help me in the future when I am grouping students together or when I have to work with other colleagues."

Preservice teacher reflections pertaining to planning and implementing curriculum were related to both technology skills and collaboration. Reflections indicated that participants realized that "planning was a major part of creating a thematic unit and no one should wait to the last minute." Reflections on planning and implementing curriculum also focused on how technology helped preservice teachers create high quality instructional units; activities that motivated and engaged the learners; and activities that addressed higher order thinking and problem solving skills. A preservice teacher's reflection stated: ". . . in my course, I learned that engaging students in higher order thinking, problem solving and group activities is a highly important part of their social studies education." Reflections also indicated that preservice teachers felt that the team work and the sharing of responsibilities when planning and designing curriculum was a positive experience.

Several challenges were expressed in the preservice teacher reflections. Equitable distribution of group responsibilities was a voiced concern. A lack of technology skills was also perceived as a challenge that most preservice teachers faced. As previously noted, preservice teachers indicated that they were anxious about using technology. For example, three said:

"When I read the requirements of the course and saw that I had to use technology, I was scared."

"I was nervous about using any form of technology."

"I didn't even know where to begin."

Reflections further indicated that preservice teachers met the challenges of technology as they worked with their peers and along with faculty to learn the technology and incorporate its use into the curriculum. Additional challenges centered around the unreliability of the actual technology. Preservice teachers also expressed their frustration as the technology did not always work or that it was not easily accessible at either the university off campus sites or at the field experience school sites.

Preservice teacher reflections clearly revealed that much learning, collaboration, and planning occurred throughout the implementation of the project. The quality of the preservice teacher projects and the amount of time devoted to creating and implementing the projects contributed to the success all students experienced.

One preservice teacher's reflection summarized the overall feelings expressed by the participants:

"Creating and implementing technology lessons has taught me patience. Success is not built overnight and it also should not be rushed. This process takes time

and with it comes frustration and anxiety. But I have learned that the use of technology is a priceless tool and resource for education."

Teacher education faculty

Results from participating and non-participating teacher education faculty surveys regarding their current understanding of constructivist pedagogy, abilities related to computer/Internet technology skills, and use of web-based learning activities with preservice teachers were compared. The comparative results indicated that both participating and non-participating faculty reported having a strong understanding of constructivist pedagogy by facilitating the construction of new knowledge through hands-on projects and cooperative group activities. Participating faculty further indicated that they encouraged the preservice teachers to build their own knowledge base and to use reflective writing to assess personal progress and understanding.

Responses related to computer/Internet technology skills showed little variation between non-participating and participating faculty abilities. Both faculty groups indicated that computer/Internet technology skills were integrated in their classes with preservice teachers using PowerPoint for developing group projects and presentations, researching and evaluating software and websites, using electronic mail for correspondence, and using the Internet for research.

The majority of the non-participating faculty indicated they used existing web-based learning activities and supplementary technology course materials with preservice teachers. Participating faculty indicated a strong use of web-based learning activities as well as the development of new technology based instructional materials by preservice teachers, for example WebQuests, online reflective journals, and web pages.

Various themes emerged from the *Net-a-Morphosis* teacher education faculty reflections (see Appendix F). The most salient themes were: collaboration among faculty; collaboration between faculty and students; and enhanced technology skills. Faculty reflections were collected through reflective writing, which provided significant opportunities for faculty to self assess their abilities to infuse technology into their course delivery as well as into their course assignments. Some Year One and Year Two faculty were anxious at the beginning of the project, especially those who had limited technology skills. However, these feelings of anxiety subsided as a result of the support and collaboration among the faculty. The GPA was viewed as a vital component for the successful implementation of technology infused activities and projects. The faculty reflections clearly identified the strong leadership and ongoing support that was provided by the project coordinator. The exchange of ideas pertaining to the infusion of technology into the courses among the participating faculty members also added to the reduction of anxiety and helped build an attitude of camaraderie.

Another theme that emerged from the faculty reflections pertained to the collaborative processes that occurred between faculty and students. The faculty reflections clearly indicated the need to work side-by-side with the students. Reflections revealed that faculty learned from students as they often stepped in and helped one another with understanding the various technology applications. Faculty members wrote that they believed their increased knowledge and abilities will continue to be infused in their future courses. The GPA, along with ongoing support and collaboration among faculty and between faculty and students, was a vital component leading to the successful infusion of technology into the preservice curriculum.

Commonalities

A common thread found in the reflections of both the preservice teachers and the participating faculty was the importance of collaboration and a supportive environment. This element encouraged participants to be creative, resourceful, and successful. As Farrell (2002) states "the theory of a supportive culture is a necessary ingredient when one is attempting to introduce, implement and sustain new initiatives within an organization" (p.7).

A second common thread was that of increased technology skills. Through a cooperative and collaborative approach preservice teachers and teacher education faculty gained the requisite skills to effectively infuse technology in P-12 programs to promote critical and creative thinking and to actively engage P-12 students in meaningful learning experiences. Through reflective practice, *Net-a-Morphosis* participants were successful in creating a nurturing and supportive community of learners.

An unexpected commonality between the preservice teacher and teacher education faculty data was the lack of significant difference in survey results between the participating and non-participating preservice teachers and participating and non-participating teacher education faculty. For both the faculty and preservice teachers, the non-participants reported having as high a degree of technology knowledge and skill as the participants. The results of the preservice survey can be explained in one of two ways: either the four-point scale was not sensitive enough to report differences or the two groups were not initially the same. Similar results were found for the faculty; however, since the faculty surveys contained open-ended questions, a more robust picture could be drawn. The brief narratives provided through the open-ended question responses

indicated that the non-participating faculty identified basic technologies and uses for these technologies as sophisticated. In contrast, participating faculty wrote about complex integrated applications of technologies infused into their students' and their own teaching practices. Tashakkori and Teddlie (1998) write that the researcher's knowledge of a particular culture, group, or organization is a valuable source of data that can guide the interpretation of results. As members of the faculty of the institution where the study was conducted, the researchers for this study possess keen insights into actual and espoused uses of technology in faculty teaching practices. Personal observations and interactions with the individuals who are the sources of data help to sculpt the data into the true images that they represent. Although non-participating faculty perceive their knowledge, skills, and use of instructional technology as advanced, when compared to that of their *Net-a-Morphosis* colleagues, their level of sophistication with instructional technology applications is merely emergent. The high ratings the non-participating faculty gave themselves on the scales in the faculty surveys may be explained by their personal understandings of the application of technology as related to their own experiences.

Implications

The implications of this project to inform teacher educators in the use of innovative applications of technology infusion and collaborative efforts with colleagues are profound. Contrary to many teaching situations where teachers and university faculty are used to working in isolation, the *Net-a-Morphosis* project provided an opportunity for preservice teachers and teacher education faculty to work collaboratively in designing instructional materials, sharing expertise, and supporting one another. This supports the

notion of "teaching as community property," which requires that teaching be made visible through the sharing of artifacts which are discussed, critiqued, exchanged, and built upon (Shulman, 1993). Teacher education faculty worked together on structuring course syllabi to accommodate the additional technology components, as well as creating technology-based activities to support course content and increase preservice teachers' technology skills. Central to this notion of peer review was more and better faculty conversation about teaching and learning. This "situated" discussion about what was being taught and how it was being taught allowed faculty members to represent and transform their habits of mind, values, methods and skills in an active community of conversation and evaluation. As the semester progressed, faculty working as teachers and colleagues assisted each other with multiple aspects of technology and content infusion, all the while considering the students and their learning. Technology became the conduit for reciprocal teaching, peer review, and collaboration – sometimes out of necessity, sometimes out of choice. Sagor (1992) found that when participants worked together, they became re-oriented, encouraging collaboration, critical discourse, and reflection with colleagues. Similar results were observed in this project as well.

One of the challenges of the project was to create a collaborative community of learners in an already existing community (i.e., the college of education). Theories of community abound, and many of the commonplaces referred to in the literature were already in place – interdependence, interaction/participation, shared interests, concern for individual and minority views, and meaningful relationships (Westheimer, 1998). The nature of the *Net-a-Morphosis* project called for participants to come together, formulate a common language, and create a unified vision for how technology would be infused at

varying levels within the teacher education program. Initially, this meant faculty working together to agree on programmatic goals and objectives, as well as individual course goals. Working side by side, individuals came together to assist one another in determining the best fit for each of the courses involved in the restructuring. Each individual's viewpoints and interests were considered, and the process led to the creation of much stronger relationships. This also included an ongoing professional development component for faculty utilizing the "Guiding Partner Approach." The meaningful social interaction fostered through the collaborative nature of the project broadened individuals' sense of self from the "me" to the "us" (Grossman, Wineburg, & Woolworth, 2000). The face-to-face interactions, dialogue, and trust required due to the nature of the project resulted in the formation of a cohesive and collaborative community of learners.

The *Net-a-Morphosis* model of technology integration is based on the framework of developmental stages of teachers. This model considers the preservice teachers and university faculty who have not included the routine infusion of technology into their teaching practices as novice technology-using teachers, according to Berliner's (1988) developmental stages. Preservice teachers and teacher education faculty became involved in the *Net-a-Morphosis* project at various stages of knowledge and expertise. Although participating teacher education faculty were not novice teachers, the use of technology as an integral part of their instructional routine was, in many cases, a novel approach. Through their collaborative efforts and reflective practice, preservice teachers and teacher education faculty were able to make decisions about the degree with which they infused technology into their practices as well as how the incorporation of technology was aligned with their personal views and philosophies about teaching and learning.

Participants, preservice teachers, and faculty integrated technology following a paradigm similar to ones described in the stages of development models, starting with basic and familiar topics, providing individuals the opportunity to develop a skill base with Internet and application tool technologies. As participants became more familiar or proficient with the technology skills, they were guided into exploring and then developing teaching strategies for technology incorporation into content areas. This was evidenced in the marked difference in the technology integration choices first and second year participating faculty made as they planned their courses early in the Fall 2002. The more experienced faculty participants sought technology applications and infusion strategies that would encourage more creativity and promote critical thinking. These participants began to develop their own applications for the use of the technology in the classroom and ultimately embraced its use as a basic element in their teaching.

In *Net-a-Morphosis in Teacher Education*, learners worked in collaborative groups. Through this collaboration, each learner built upon the experiences and knowledge of peers to arrive at a personally constructed meaning of her/his involvement. Preservice teachers and faculty members embraced a constructivist approach in their infusion of technology. Additionally, participants constructed personal meaning from the learning situation based on prior experiences and knowledge. Learners (preservice teachers and faculty members) constructed their own personal meanings from the knowledge and skills acquired while infusing technology. These personal meanings were communicated in the form of written reflections.

Developing the reflective capacities of preservice teachers for the purpose of increasing their effectiveness with future students was one of the purposes of this study.

Throughout the process, faculty were engaged in ongoing reflection along with their students, thus increasing their effectiveness as well. When teachers become reflective practitioners, engaging in inquiry-oriented teaching, they begin a cycle of thought and action based on professional experience. It embraces a methodology of narrative inquiry. Reflection was an integral part of the *Net-a-Morphosis* project, and all along the way preservice teachers and faculty were encouraged to reflect and share in the process and its implications.

The teacher education courses included in the project were constructivist in nature, requiring that faculty model constructivist pedagogy which involved preservice teachers in hands-on, active learning centered on content and strategies. The integration of content, processes, skills, and dispositions woven into the courses, along with the strong reflective component, was used to counter the tendency in teacher education to mold passive technicians.

There are many factors which contribute to the culture of teaching, and subsequently are influences on the teacher's ability to be a reflective practitioner. Social forces influencing what happens in schools today are numerous. Grounding preservice teachers in reflection is necessary to providing them with the skills and dispositions that they will need once they are out in the "real world" of teaching. Immersion in experiences such as *Net-a-Morphosis* are essential to this grounding. The reflective component of this project served to help preservice teachers and teacher educators internalize the learning experience and understand it in more depth.

Conclusion

As teacher educators seek to improve the quality of education through the use of new methodologies and resources, they become learners side-by-side with their preservice teachers. Teaching becomes a reciprocal, collaborative process impacted by the values and dispositions of teacher and learners. Through collaboration, reflection, and reciprocal teaching all participants became both teachers and learners, reflective of their developmental levels. The results of this study offer insights into the use of technology in teacher education programs as a vehicle to promote collaboration, reflection, and changes in instructional practices.

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Appendix A

Net-a-Morphosis in Teacher Education Courses

Course Title	Description	Number of Students
YEAR 1		
EDU 151: Introduction to Education	Preservice teachers engaged in observation, analysis, reflective thinking and writing, and collaboration through their Field Experience observations	24
EDU 360: Children's Literature	Preservice teachers explored service learning as a practical and pedagogical tool for K-6 and researched and developed web-based "authentic" children's literature instructional reading activities.	12
EDU 362: Teaching Mathematics in the Elementary School	Preservice teachers reviewed resources such as software and websites and on-line journals related to teaching mathematics skills. Pre-service teachers created PowerPoint presentations to teach a variety of mathematics topics. The PowerPoint Learning Centers were implemented during field experience.	25
ESE 424: Learning Disabilities Characteristics, Identification, & Teaching Strategies	Preservice teachers developed web-based modules and in the areas of reading, spelling and mathematics for children with special needs.	19
EDU 441: Primary/ Elementary School Curriculum	Preservice teachers worked in groups to plan, design, and develop a complete integrated unit that incorporated a variety of technology based activities.	10
EDU 466: Diagnostic Teaching of Reading in the Primary/ Elementary Classroom	Preservice teachers explored the role of technology in addressing the needs of diverse learners and researched and developed web-based "authentic" corrective/remedial instructional reading activities.	12
TSL 476: Methods of Teaching English as a Second Language	Preservice teachers identified, developed, and implemented methods strategies and approaches applicable for English Language Learners using technology.	24
YEAR 2		
EDU 151: Introduction to Education	Preservice teachers engaged in observation, analysis, reflective thinking and writing, and collaboration through their Field Experience observations	23
EDU 366: Teaching Social Studies in the Elementary School	Preservice teachers reviewed appropriate resources such as software and websites and on-line journals related to teaching Social Studies. Preservice teachers created problem based WebQuests and implemented the WebQuests at their field experience schools.	20
TSL 406: Applied Linguistics	Preservice teachers developed second language acquisition activities and upload the activities to the ThinkQuest website.	26
EDU 417: Evaluation and Measurement in Education	Preservice teachers used both formative and summative data addressing each of the course/project objectives (educational evaluation and measurement, service learning, diversity and technology).	24
EDU 441: Primary/ Elementary School Curriculum	Preservice teachers worked in groups to plan, design, and develop a complete integrated unit. Students incorporated a variety of technology-based activities.	14
TSL 476: Methods of Teaching Limited English Proficient	Preservice teachers created PowerPoint presentations that focused on facilitating family involvement in education.	18
TSL 509: Cross-Cultural Communication	Preservice teachers developed on-line journals in the field pertaining to an understanding of cross cultural communications.	15
EDU 552: Critical Thinking in Elementary School Science and Social Studies	Preservice teachers utilized technology as a viable teachers' tool for identifying curricular resources for science and social studies materials, including ESOL paraphernalia; design a problem-based WebQuest.	15

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Appendix B

ThinkQuest T3 Catalyst Grant Exiting Preservice Teacher Questionnaire

Exiting Preservice Teacher Questionnaire

ThinkQuest PT3 Catalyst Grant
Exiting Preservice Teacher Questionnaire

Student Name:
Name of University:
Date:
The following are a list of technology standards and performance indicators*. In order to improve our program, we would like you to assess your preparedness, as a future teacher, to use technology as it relates to these standards and indicators. Note: this information will not be used to assess you personally, but rather will be used to help evaluate our current teacher preparation program as it relates to technology.

For each question, please fill in the one circle that best describes your response: Correct mark ● Incorrect mark ⊘ ✖ ◒

	Not Prepared	Somewhat Prepared	Prepared	Well-Prepared
I. TECHNOLOGY OPERATIONS / CONCEPTS				
1. Apply introductory knowledge, skills and understanding of concepts related to technology	O	O	O	O
II. PLANNING AND DESIGNING LEARNING ENVIRONMENTS				
2. Design developmentally appropriate learning opportunities that apply technology-enhanced instructional strategies to support the diverse needs of learners	O	O	O	O
3. Apply current research on teaching and learning with technology when planning learning environments and experiences	O	O	O	O
4. Identify and locate technology resources and evaluate them for accuracy and suitability	O	O	O	O
5. Plan for the management of technology resources within the context of a learning activity	O	O	O	O
6. Plan strategies to manage student learning in a technology-enhanced environment	O	O	O	O
III. TEACHING, LEARNING AND THE CURRICULUM				
7. Facilitate technology-enhanced experiences that address content standards and student technology standards	O	O	O	O
8. Use technology to support learner-centered strategies that address the diverse needs of students	O	O	O	O
9. Use technology to develop students' higher order skills and creativity	O	O	O	O

	Not Prepared	Somewhat Prepared	Prepared	Well-Prepared
10. Manage student learning activities in a technology-enhanced environment	O	O	O	O
IV. ASSESSMENT AND EVALUATION				
11. Apply technology in assessing student learning of subject matter using a variety of assessment techniques	O	O	O	O
12. Use technology resources to collect and analyze data, interpret results, and communicate findings to improve instructional practice and maximize student learning	O	O	O	O
13. Apply multiple methods of evaluation to determine students' appropriate use of technology resources for learning, communication, and productivity	O	O	O	O
V. PRODUCTIVITY & PROFESSIONAL PRACTICE				
14. Use technology resources to engage in ongoing professional development and lifelong learning	O	O	O	O
15. Evaluate and reflect on professional practice in order to make informed decisions regarding the use of technology in support of student learning	O	O	O	O
16. Apply technology to increase productivity	O	O	O	O
17. Use technology to communicate and collaborate with peers, parents, and the larger community in order to nurture student learning	O	O	O	O
18. Model and teach legal and ethical principles related to technology use	O	O	O	O
19. Apply technology resources to enable and empower learners with diverse backgrounds, characteristics, and abilities	O	O	O	O
20. Identify and use technology resources that affirm diversity	O	O	O	O
21. Promote safe and healthy use of technology resources	O	O	O	O
22. Facilitate equitable access to technology resources for all students	O	O	O	O

Thank you for your very important input.

*These are the ISTE National Educational Technology Standards (NETS) and Performance Indicators for Teachers

Appendix C

Final T-3 Project Reflection Activity

As a culminating reflection activity for this project, respond to each of the following categories:

Experiences:
Activities in which you engaged-what you saw, heard, and felt.
This should be a brief list of the activities in which you participated in researching and developing your group T-3 project.

Sensory Input:
What did you see and hear that was important? Pretend you are a TV reporter and you have a videotape camera with you. (Make no judgment here – just record)
Feelings. Use of emotion words (e.g., happy, surprised, frustrated, anxious) to describe your feelings of web-based activities including using the computer as a teaching tool.

Processing:
Reflecting on your observations – what, specifically, have you learned?
Thoughts/Opinions. Interpret what you have learned. What does it mean to you?
Knowledge/Skills – What knowledge and/or skills did you acquire? What have your learned about yourself?

Generalizing:
How do concepts from this project add to your understanding?
Identifying issues/problems.
Developing hypotheses. (i.e., asking questions*) As a result of your experience, what questions do you have? What do you want to find out? (Curiosity is the first essential for learning, so the more questions, and the better).
Making connections to psychological and educational theories, principles, and concepts. Here you need to make specific mention of course concept(s).

Practical Application:
What might you try next time?
Given the processing and generalization you have done above, what can you do differently next time?
Active experimentation. This may lead to new reflections.

Appendix D

ThinkQuest T3 Catalyst Project University Participating Faculty Annual Survey

ThinkQuest PT3 Catalyst Project
University Participating Faculty Annual Survey

Name:

School:

Date:

1. Please describe how you have been involved (if at all) with the ThinkQuest PT3 project?

2. How would you rate your current knowledge in the following areas?

	Non-Existent	Limited	Strong	Excellent
Constructivist Pedagogy	☐	☐	☐	☐
Computer/ Internet Technology Skills	☐	☐	☐	☐
Use of Web-based Learning Activities with Preservice Teachers	☐	☐	☐	☐

3. Please describe how you currently integrate each of the following core elements into your classes with preservice teachers:

   A. Constructivist Pedagogy?

   B. General Technology Skills?

   C. Web-based Learning Activities?

4. How often do you currently use a computer for:

	Daily	Never	Monthly	Weekly
A. Productivity programs (word processing, spreadsheet, database)?				
B. E-mail?				
C. Accessing the Internet?				
D. Preparing information/tests?				
E. Keeping/preparing grades?				
F. Doing research				
G. Creating lessons, units or projects?				
H. Creating Web pages?				

5. Please read the descriptions of each of the six stages related to adoption of technology. Check the number of the stage that best describes your level at this time.

	Stage 1: Awareness - I am aware that technology exists but have not used it, perhaps I'm even avoiding it.
	Stage 2: Learning the process - I am currently trying to learn the basis. I am sometimes frustrated using computers. I lack confidence when using computers.
	Stage 3: Understanding and Application - I am beginning to understand the process of using technology and can think of specific ways in which to use it.
	Stage 4: Familiarity and confidence - I am gaining a sense of confidence in using the computer for specific tasks. I am starting to feel confident and comfortable.
	Stage 5: Adaptation to other contexts - I think about the computer as a tool to help me and am no longer concerned about it as technology. I use it in many applications and as an instructional aid.
	Stage 6: Creative applications to new contexts - I can apply what I know about technology in the classroom. I am able to use it as an instructional tool and integrate it into the curriculum.

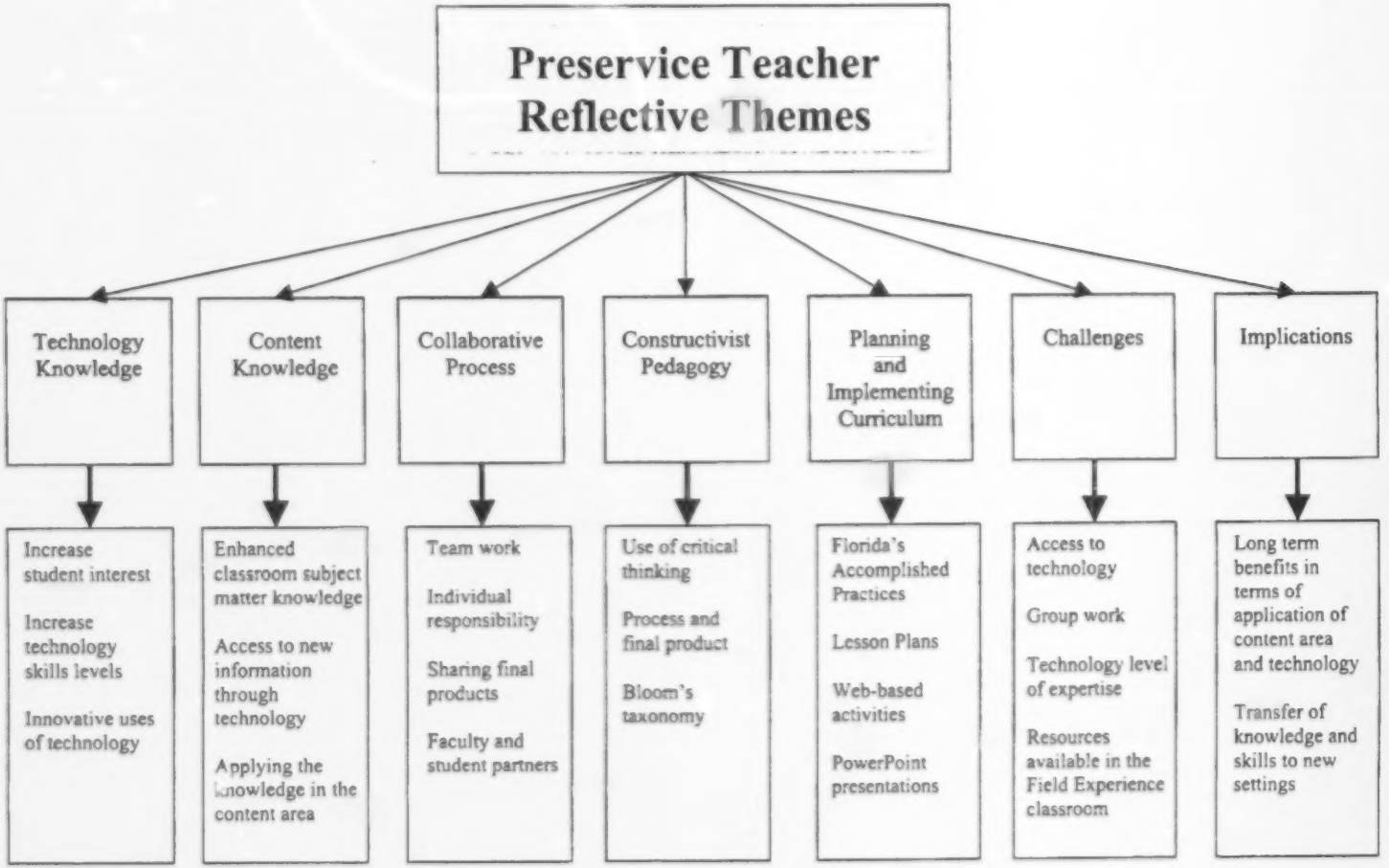
6. Please answer the following questions pertaining to capacity building?

   A. Is the ThinkQuest PT3 Project making changes in preservice teacher education at your college/university teacher preparation program? Please explain.

   B. What additional resources are needed in order to make the adoption of the ThinkQuest PT3 Project at your institution more successful?

Appendix E

Participating Preservice Teacher Reflective Themes



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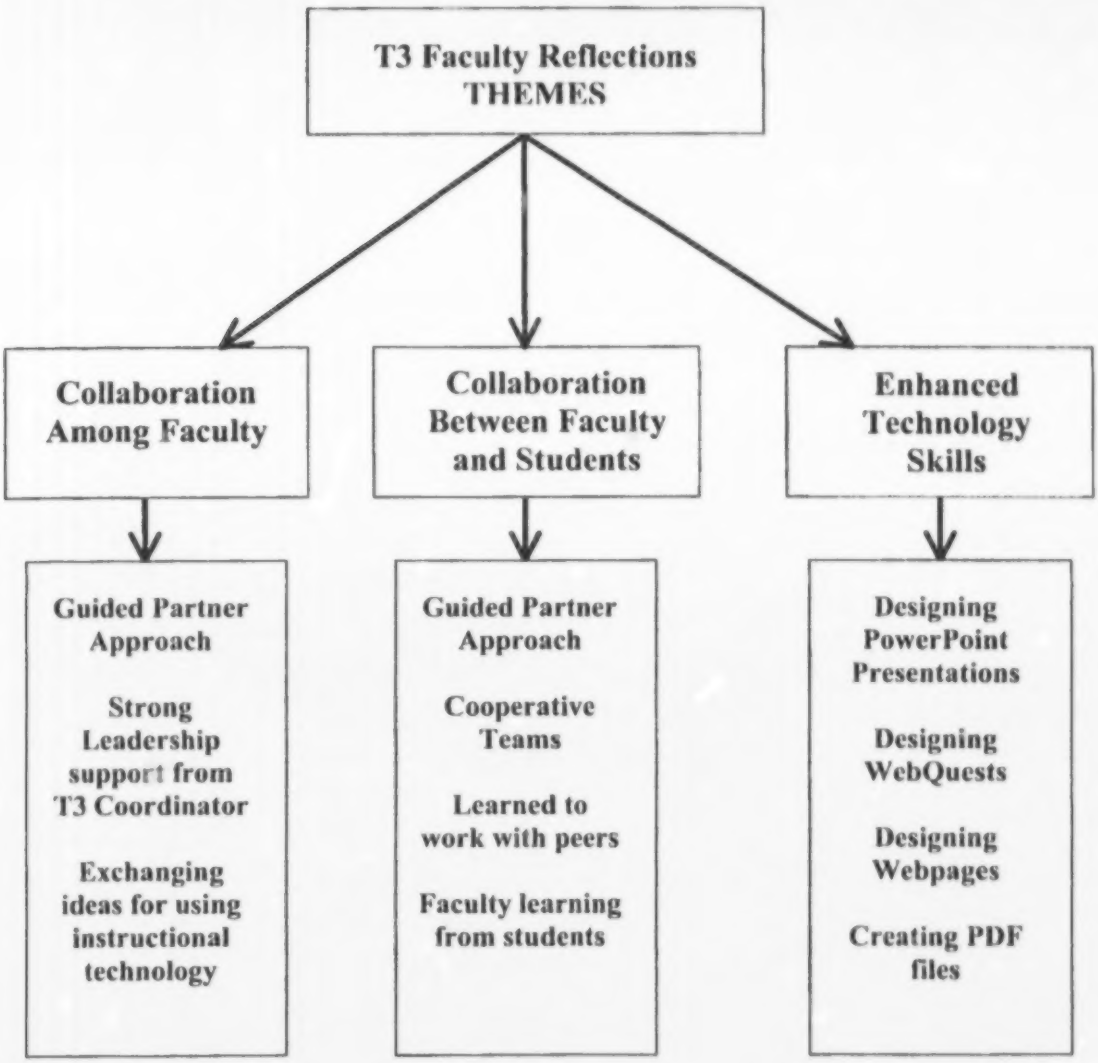
Appendix F

Net-a-Morphosis in Teacher Education Faculty Reflection Themes



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